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LABORATORY INFECTIONS

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## Introduction

During their stay and their work in medical-biological laboratories people can become infected. A laboratory infection is the invasion of the human organism by disease agents worked with for diagnostic or research purposes, or occurring in the laboratory for other reasons. In the following they will be called in short "laboratory germs." The consequence of a laboratory infection need not always be observable disease symptoms. So-called silent infections also may turn out to be of importance. As an example, fetal damage following a clinically not observable infection with toxoplasma may be quoted (3).

With the advances of science and technology, laboratory examinations are extended to an increasing number of disease agents. Likewise, the work methods to which the germs are subjected increase in number and complexity. As a consequence, there will be more and more infections of personnel. In the following, we report on the cause and frequency of laboratory infections and on measures for the protection of personnel. Other injuries which may be experienced by persons working in the laboratory (such as surgical injuries, burns, intoxications) are not discussed here.

## Causes

One of the sources of infection in the laboratory are artificially or naturally infected laboratory animals. An example is the transmission of animal fungus diseases of the skin to the attendants. Likewise, infections from man to man must be considered as laboratory infections if the infection occurred during stay in the laboratory and the infecting person had been infected with laboratory germs. Most laboratory infections occur if disease agents get out of control during laboratory procedures. Happenings of this kind can be divided into two groups: accidents and work techniques which are generally considered as harmless and not suspicious. Table 1 lists the most common accident-type occurrences by which disease agents can be transmitted to the laboratory personnel. They are mainly a consequence of lack of attention and of caution by the personnel. Furthermore, faulty material and other, unpredictable happenings play a part in their development. The connection between the cause and the infection is mostly - but definitely not always - easily recognizable, so that an expert opinion on such cases can be arrived at with little difficulty. According to Wodum (29), between 14 and 35% of laboratory infections in the U.S.A. could be related to recognizable, accident-type occurrences.

Table 1. Laboratory Infections by Accident-type Occurrences

| Source of germ (=infectious material) | Accident |
|---|---|
| Container (e.g. flasks, Petri dishes, test tubes, etc.) | 1) Direct touching of the material, 2) Bursting of container (by hitting and the like), possibly with injury, 3) Spilling of material (by pouring into another vessel, inoculation, and the like), 4) Breakage in the centrifuge |
| Egg cultures | 1) Breakage of infected eggs, 2) Spilling of infectious material (e.g. during inoculation) |
| Injection syringes | 1) Injury by needle, 2) Spilling of infectious material (e.g in removing air from the syringe, by coming off of the needle) |
| Pipettes | 1) Sucking in, 2) Spilling of infectious material |
| Experimental animals (infected naturally or artificially) | 1) Injury by biting or scratching, 2) Touching (of the animals, the cadavers, autopsy material, excreta) |

The question remains of the sources of infection for those diseases for which a causative occurrence is not easily found. Some cases go back to the fact that persons, without noticing it, have physical contact in the laboratory with germ-containing material which was spilled inadvertently and unobsorvedly, perhaps in inoculation of cultures from one media to the other. Not a small part of laboratory infections can be traced to work procedures of which first Johansson and Ferris (11) and later other researchers (4, 14, 17, 19, 20, 21, 24, 26, 27) showed that they permit the microorganisms to escape unchecked into the surroundings. Liquids scatter as spray if they are suddenly braked, e.g. by hitting an obstacle, whereby the liquid particles formed are the smaller, the quicker the procedure is (2). As can be seen from Table 2, it is mainly routine, everyday laboratory procedures which, by this mechanism, may result in a spray or aerosol which, depending on circumstances, may contain germs. This way, not only the working place itself, but also the other surfaces and the air in the laboratory and in the adjoining rooms become infected. The personnel is the more endangered because these actions are throughout considered as innocuous, and the scattering of germs occurs unnoticed and remains unrecognized. Also accident-type happenings, e.g. the bursting of a culture container, often result in the development of a germ aerosol and thereby can cause an aerogenous infection of the personnel.

Table 2. Laboratory Infections by Routine Work Procedures

| Procedures (with infectious materials) | Cause of dispersal of disease agents (mostly as spray or aerosol) |
|---|---|
| Centrifuging | 1) Rim of centrifuge tube infected,<br>2) Breakage of tube in the centrifuge,<br>3) Opening of the tube after centrifuging,<br>4) Decanting of centrifuged liquids |
| Shaking, mixing, stirring, homogenizing | 1) Working with uncovered vessels,<br>2) Removal of covers after shaking, etc. |
| Pestling | 1) Work with germ cultures, infectious organ parts, and the like without protective device |
| Pipetting | 1) Blowing out the pipettes,<br>2) Quick movement, hitting, dripping,<br>3) Intranasal infection of animals |
| Handling of smear loops | 1) Spread by rubbing, skimming off, knocking off,<br>2) Quick movement through the air,<br>3) Touching of hot loop with infectious material,<br>4) Singeing, annealing |

Table 2 (continued)

| Procedures (with infectious materials) | Cause of dispersal of disease agents (mostly as spray or aerosol) |
|---|---|
| Handling infectious syringes | 1) Removal of superfluous liquid or air, 2) Pulling out of needle from rubber stoppers, 3) Inoculation of experimental animals |
| Freeze-drying | 1) Filter of vacuum pump inadequate, 2) Opening of vessels with lyoph. cult. |

Types of Germs

All kinds of germs are capable of causing infections of laboratory personnel. What diseases occur, depends in the first place on the type and performance of the studies and on the infectiousness of the germs. Among the notified occupational diseases of the laboratory personnel, tuberculosis, brucellosis, hepatitis, and infectious intestinal diseases are the most common ones (9, 21, 24, 29). Diagnostic tests with the causative agents of these diseases are performed in many laboratories. There where experiments with rickettsia, with smallpox and virusses of the arbo group, with tularemia bacteria or toxoplasma are undertaken, diseases from these agents are relatively common because of their high infectiousness. In special laboratories, unusual diseases occur among the personnel, caused e.g. by the monkey-B-virus (15) or the salivary gland virus of bats (22). The implementing regulation to the 6th decree on occupational diseases mentions, as No. 37, infectious diseases. In the pertinent memorandum (6) many communicable diseases are listed, which fact may result in the misunderstanding that only these may be considered as occupational diseases. However, a large number of laboratory infections have been described (e.g. histoplasmosis, coccidioidomycosis, infections with adeno-, echo-, Newcastle disease virusses) which are not named in the list. It seems therefore to be advisable to dispense in that paper with individual citation of all those disease agents which can be transmitted to man in an exposed occupation. Instead of that, it would be sufficient to point out the multiplicity of infectious diseases.

Transmission

In the laboratory, just as in nature, disease agents are transmitted to man by various routes: by means of vehicles, by vectors, by contact, and by air. Of importance in the laboratory are the two last-named types of transmission (14, 21, 24). With accident-type occurrences (see Table 1), contamination takes place preponderantly by direct or indirect contact. So far, the aerogenous route of infection, by which - as Wedum (27) reports - approximately 65% of all laboratory infections are transmitted, has been paid little attention. According to Sulkin (21), most laboratory infections which cannot be traced to technical mistakes or accidents, can be related to inhaling of infectious material. The development of infection in the host organism after aerogenous transmission depends on many factors; particularly to be mentioned are particle size, and type and number of germs (12, 16).

While larger particles, after inhalation, are stopped in the upper air passages, particles of less than 5 microns also get into the lower parts of the respiratory tract. In the laboratory there are germ-containing floating particles of both size ranges. Many disease agents attach themselves to the upper air passages and start a disease from here, e.g. diphtheria, whooping cough, measles, influenza, and respiratory streptococcus infections. These diseases are therefore mainly transmitted by droplet spray. In order to cause an infection, other germs must be enabled to settle down in those parts of the respiratory organs which are not any more protected by ciliated epithelium. Therefore, the causative agents of pulmonary tuberculosis, pulmonary mycoses, ornithosis, and Q-fever, are transmissible only in the form of smallest floating particles.

In technical plants where germ-containing aerosols are created, people can inhale also such disease agents the mode of infection of which under natural conditions is rarely or never aerogenous. An example is brucellosis among workers in food factories. The people are exposed to a brucella-containing aerosol which is produced by machines cutting up the meat. Also in the laboratory, aerogenous infections with the bacteria of brucellosis, tularemia, and glanders, with typhus rickettsiae, with the viruses of yellow fever and encephalitis, and even with the agents of lymphogranuloma have been observed. Not excluded are diseases after inhalation of hepatitis, choriomeningitis and poliomyelitis viruses, of typhoid bacteria, of leptospira and toxoplasma. This way, unusual and new types of diseases can develop, the recognition and treatment of which is made difficult (2).

As studies with tuberculosis bacteria and the agents of tularemia and Q-fever have shown (13, 16, 25, 28), even few of these germs, after inhalation and deposition in the lower air passages, are capable of producing a disease in man and animal. Therefore, in order that a laboratory infection should start, a massive dispersion of germs and infection of the respiratory air is by no means necessary.

Prognos

Not infrequently the opinion is expressed that stay and work in medical-biological laboratories is dangerous only to a small extent

(5, 10, 32). The mentioned reason for that is that the sources of danger are known and, with correct procedure, the germs can be kept under control, that the personnel know how to protect themselves, and that infections could occur only by a coincidence of unfortunate circumstances. For that reason, the infection risk of nursing personnel in infectious wards is said to be considerably higher than that of laboratory personnel.

The basis for such assertions is often material from accident statistics (5, 10). But then it is not taken into account that absolute figures do not permit any statements on disease incidence. Also the figure of 2,348 laboratory infections including 107 fatalities, mainly from the U.S.A., which Sulkin (21) has reported, does not give any information on the infection quota in microbiological laboratories. Henze (9) in Berlin and Reid (18) in England have related the number of disease cases to the number of employed, and to the number of disease cases in socially comparable occupational groups, respectively. Both authors came to the conclusion that in any case within the examined group of persons the technical laboratory workers were in relatively great danger of laboratory infections.

The common underestimation of the frequency of laboratory infections is based mainly on the lack of knowledge of the development of infectious aerosols in the laboratory. Because it is often unknown that, under usual work conditions, an uncontrolled escape of disease agents cannot always be avoided, some disease cases are considered by the patients as well as by the experts as acquired outside of the occupation. In fact, the infection occurred in the laboratory; it was only not possible to prove the happening which triggered it. At times, we are also dealing with clinically slight or even not noticeable infections which do not, or only for a short time, result in incapacitation for work and which therefore do not show up in statistics.

## Protective Measures

Protection of the personnel from laboratory infections includes the prevention of contamination as well as social security measures for the diseased.

Measures for the prevention of infection are not very well liked. They do not show quick and impressive successes. Instead of that, one sees clearly their disadvantages in the form of increased financial burdens for the people in charge of the laboratories, and of increased difficulty of work for the personnel. It is therefore important to convince all concerned of the necessity and urgency of protective measures, which can be achieved best by an objective study and discussion of the dangers of infection. Success or failure of all measures depend largely on the attitude, frankness, and efficiency of the leading persons in the laboratory.

Individually, the prophylactic measures extend to the following fields:

1. In the building plan and technical equipment of the laboratories and the technical design of the laboratory apparatus, the modern knowledge of transmission of infectious germs should be taken into consideration (17, 19, 28, 30, 31).

2. Likewise, the work methods and procedures are to be selected in such a way that accidents are reduced to a minimum and an uncontrolled escape of laboratory germs is avoided as far as possible (7, 17, 19, 20, 28). Which ones of the disease agents present a particular aerogenous danger to the personnel, so that work with them must be performed in the inoculation chamber, is shown in Table 3.

3. Preventive and diagnostic examinations as well as inoculations of the personnel are to be determined and performed, their kind and timely arrangements depending on the field of work.

4. The accident regulations valid in the Federal Republic (8) are outdated. They are in need of being supplemented and expanded, particularly in view of the danger of infection by aerosols. It is to be recommended to incorporate the 24 operating instructions for laboratory personnel which Wedum (28) has established in the protective regulations and to make them known to the personnel by display in the rooms of the laboratory.

5. In the courses of study for academic and technical laboratory personnel, more should be taught about kinds and prevention of laboratory infections than has been done so far.

Table 3. Prevention of Aerogenous Laboratory Infections (after Wedum, 28)

| Agent | Laboratory work in the inoculation chamber |
|---|---|
| Tuberculosis bacteria<br>Brucellosis bacteria<br>Glanders bacteria<br>Pseudo-glanders bacteria<br>Virus of Russian spring-summer encephalitis<br>Rift valley virus<br>Coccidioides | unconditionally necessary |
| Rickettsiae (typhus, Q-fever, etc.)<br>Ornithosis virus | urgently to be recommended |

Table 3 (continued)

| Agent | Laboratory work in the inoculation chamber |
| --- | --- |
| Viruses of the arbo group<br>Other encephalitis viruses<br>Tularemia bacteria | urgently to be recommended |

According to the 6th decree on occupational diseases which is in force, infectious diseases are recognized as occupational diseases if they occur in persons who are exposed to a considerably increased danger of infection, as, e.g., those working in laboratories for scientific and medical examinations and experiments (6). It may be difficult for the expert to delimit whether an infectious disease originated within, or in a natural way outside of, the plant presenting danger. If he underestimates the occupational risk in the laboratory, he will be inclined to assume the probability of an extra-occupational infection if he cannot find an accidental occurrence in the laboratory. That such a way of thinking is not correct, is clear from the above discussions. On the contrary, in cases of diseases which are or can be caused by germs occurring in the laboratory, a casual relationship between professional work, damaging influence, and disease should always be assumed even if an accident-type occurrence cannot be ascertained (1). If at the same time there is an extra-professional source of infection, the infection risk must be weighed. With Wedum (28) I am of the opinion that every disease of a person exposed in a laboratory is to be considered as occupational as long as the opposite cannot be proved.

## BIBLIOGRAPHY


1. Albrecht, J.: "Danger of Infection inthe Tuberculosis Sanatorium", Tuberk.-Arzt (Tuberculosis Doctor) 15:563-566 (1961).

2. Albrecht, J.: "Danger by Infectious Aerosols in the Laboratory", in H. Nueckel: Fortschritte der biologischen Aerosolforschung (Progress in Biological Aerosol Research), Stuttgart (1962).

3. Albrecht, J.: "Laboratory Infections and Female Laboratory Personnel", Aerztl. Mitt. (Medical Reports) 60:1775-1776 (1963).

4. Anderson, R.E., L. Stein, M.L. Moss, and N.H. Gross: Potential Infectious Hazards of Common Bacteriological Techniques, J. Bact. 64: 473-481 (1952).

5. Brinkmann, O.: "Tuberculosis as Occupational Disease of Medical and Nursing Personnel and its Prevention", Therapiewoche (Therapy Week) 6:188-194 (1956).

6. Bundesminister fuer Arbeit und Sozialordnung (Federal Minister for Work and Social Regulation): "Leaflets on Occupational Diseases According to the 6th Decree on Occupational Diseases", Dtsch. Aerztebl. (German Physicians' Paper) 61:259-262 (1964).

7. Cook, E.B.M.: Safety in the Public Health Laboratory, Publ. Hlth Rep. (Wash.) 76: 51-56 (1961).

8. Gemeindeunfallversicherungsverband (Community Accident Insurance Association) Rheinland/Pfalz: Unfallverhuetungsvorschrift medizinische Laboratoriumsarbeiten (Accident Prevention Regulation, Medical Laboratory Work), Andernach (1960).

9. Hense, B.: "Infectious Diseases as Occupational Danger for Persons in Medical and Nursing Facilities", Zbl. Arbeitsmed. (Central Journal of Work Medicine) 12: 134-138 (1962).

10. Jensen, E.: "Medical-Clinical Experiences on Tuberculosis as Occupational Disease by Laboratory Infection", Tuberk.-Arzt (Tuberculosis Doctor) 13: 473-478 (1959).

11. Johansson, K.R., and D.H. Ferris: Photography of Airborne Particles During Bacteriological Plating Operations, J. Infect. Dis. 78: 238-252 (1946).

12. Langmuir, A.D.: Epidemiology of Airborne Infection. Bact. Rev. 25: 173-181 (1961).

13. Langmuir, A.D.: Airborne Infection: How Important for Public Health? I. A Historical Review. Amer. J. Publ. Hlth. 54: 1666-1668 (1964).

14. Long, E.R.: The Hazard of Acquiring Tuberculosis in the Laboratory, Amer. J. Publ. Hlth 41: 782-787 (1951).

15. Love, F.M., and E. Jungherr: Occupational Infection with Virus B of Monkeys, J. Amer. Med. Ass. 179: 804-806 (1962).

16. McCrumb, F.R.: Aerosol Infection of Man with Pasteurella Tularensis, Bact. Rev. 25: 262-267 (1961).

17. Morris, E.J.: A Survey of Safety Precautions in the Microbiological Laboratory, J. Med. Lab. Technol. 17: 70-81 (1960).

18. Reid, D.D.: Incidence of Tuberculosis Among Workers in Medical Laboratories. Brit. Med. J. II: 10-14 (1957).

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5. Brinkmann, O.: "Tuberculosis as Occupational Disease of Medical and Nursing Personnel and its Prevention", Therapiewoche (Therapy Week) 6:188-194 (1956).

6. Bundesminister fuer Arbeit und Sozialordnung (Federal Minister for Work and Social Regulation): "Leaflets on Occupational Diseases According to the 6th Decree on Occupational Diseases", Dtsch. Aerztebl. (German Physicians' Paper) 61:259-262 (1964).

7. Cook, E.B.M.: Safety in the Public Health Laboratory, Publ. Hlth Rep. (Wash.) 76: 51-56 (1961).

8. Gemeindeunfallversicherungsverband (Community Accident Insurance Association) Rheinland/Pfalz: Unfallverhuetungsvorschrift medizinische Laboratoriumsarbeiten (Accident Prevention Regulation, Medical Laboratory Work), Andernach (1960).

9. Henze, B.: "Infectious Diseases as Occupational Danger for Persons in Medical and Nursing Facilities", Zbl. Arbeitsmed. (Central Journal of Work Medicine) 12: 134-138 (1962).

10. Jensen, E.: "Medical-Clinical Experiences on Tuberculosis as Occupational Disease by Laboratory Infection", Tuberk.-Arzt (Tuberculosis Doctor) 13: 473-478 (1959).

11. Johansson, K.R., and D.H. Ferris: Photography of Airborne Particles During Bacteriological Plating Operations, J. Infect. Dis. 78: 238-252 (1946).

12. Langmuir, A.D.: Epidemiology of Airborne Infection. Bact. Rev. 25: 173-181 (1961).

13. Langmuir, A.D.: Airborne Infection: How Important for Public Health? I. A Historical Review. Amer. J. Publ. Hlth. 54: 1666-1668 (1964).

14. Long, E.R.: The Hazard of Acquiring Tuberculosis in the Laboratory, Amer. J. Publ. Hlth 41: 782-787 (1951).

15. Love, F.M., and E. Jungherr: Occupational Infection with Virus B of Monkeys, J. Amer. Med. Ass. 179: 804-806 (1962).

16. McCrumb, F.R.: Aerosol Infection of Man with Pasteurella Tularensis, Bact. Rev. 25: 262-267 (1961).

17. Morris, E.J.: A Survey of Safety Precautions in the Microbiological Laboratory, J. Med. Lab. Technol. 17: 70-81 (1960).

18. Reid, D.D.: Incidence of Tuberculosis Among Workers in Medical Laboratories. Brit. Med. J. II: 10-14 (1957).